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**Civilian Radioactive Waste Management System  
Management & Operating Contractor**

**Retrievability Strategy Report**

**B00000000-01717-5705-00061 REV 00**

**April 1997**

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## PREFACE

Section 122 of the *Nuclear Waste Policy Act* requires that a repository be "designed and constructed to permit retrieval of any spent fuel placed in such repository, during an appropriate period of operation of the facility," for one of these reasons:

- To protect "public health and safety, or the environment"
- To permit "the recovery of the economically valuable contents of such spent fuel."

The Act also requires the Secretary to specify an appropriate period of retrievability at the time of the design of a repository. The Secretary has not yet defined any such period. However, the Nuclear Regulatory Commission, in the Code of Federal Regulations Title 10 Part 60.111, requires the design of a geologic repository operations area to allow the retrieval of any or all waste "on a reasonable schedule starting at any time up to 50 years after waste operations are initiated...." NRC describes a "reasonable schedule" as one that would permit retrieval in about the same time as it took to construct the repository and emplace the waste.

Based on the existing conceptual repository and waste package design and analysis, the Yucca Mountain Project described retrieval operations under normal and abnormal conditions in the 1988 *Site Characterization Plan (SCP)* document. In 1991, under the same design assumptions, the Project issued a *Retrieval Strategy Report for a Potential High-Level Nuclear Waste Repository*. Both the conceptual design of the waste package and the emplacement methods have since changed significantly.

This report presents the results of a study to determine whether and to what degree these design and other changes require a revision of the retrieval strategy and, if they do, to recommend a revised strategy. The aim of such a revised strategy was to inform decision makers on how to proceed with design to allow retrievability. In particular, the strategy was to describe the process by which retrieval would be executed and to contain sufficient details, recommended design alternatives, and the technical rationale to:

- Support the development of the *License Application*
- Provide a technical basis for each retrievability design requirement in the FY 97 *Retrieval Design & Operation Report for the Viability Assessment*.

As part of the study, a thorough literature search was conducted and the relevant strategy and other technical documents were evaluated. A compliance and licensing assessment was also developed to determine the level of detail required for the retrieval section of the *License Application*.



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## EXECUTIVE SUMMARY

### KEY FINDINGS

**Need for a Revised Strategy.** Major changes in repository and waste package concepts have occurred since the 1988 *Site Characterization Plan*. Current design calls for far larger and heavier unshielded waste packages, for the emplacement of fewer packages, and for in-drift emplacement. As a result, past retrieval strategies are, in some respects, no longer valid and a revised strategy is required to reflect these changes.

**Preserving the Retrieval Option.** The Nuclear Regulatory Commission and the Department of Energy documents on retrieval generally require that the repository be designed so that retrieval is a practical option, that retrieval is not so expensive, difficult, or dangerous that the option is foreclosed. NUREG-0804 states the the agencies also "foresee no situation where protection of public health and safety would require the waste to be removed very rapidly." (NRC1983)

These documents also make a clear and sharp distinction between retrieval and all other kinds of removal and movements of waste that occur during the period during which waste is emplaced. Retrieval would occur only as a result of a top policy decision by the Department of Energy and the Nuclear Regulatory Commission to protect public health and safety or the environment, or to recover resources from the spent fuel. It is expected to take years, perhaps decades, to accomplish and may be very difficult. All other movements or recovery of waste for any other reason will occur as part of normal repository operations, and will not be governed by the regulations and requirements for retrieval as defined by the *Nuclear Waste Policy Act* and by the Nuclear Regulatory Commission. However, the capability developed to conduct those operations safely and efficiently even under adverse conditions will also be used to perform any retrieval operations. Current plans for use of very large unshielded waste packages, which must be moved and emplaced remotely, may require the repository design to include a robust ground support system to assure safe and easy access to packages and drifts throughout the operational period. Any operations required for retrieval would take advantage of this same system and features. This report identifies design requirements derived from the proposed retrieval strategy that are in addition to those requirements already established for the operational period of the repository.

**Retrieval under the Current Design.** Over a range of seven scenarios, both normal and abnormal, retrieval remains possible within the current mined geologic disposal system conceptual design. The strategy outlined in this report describes, in the level of detail consistent with current design details, how to retrieve waste in each of the seven scenarios with the current Mined Geologic Disposal System design. No equipment beyond that required for current operational plans will be required.

**Expected Retrieval Environment.** The main features of the repository that could affect the expected retrieval environment include seismicity, geomechanics (rockfall), water in-flow, temperature and radiation levels. An evaluation of these features shows that:

- The likelihood of emplacement-drift-damaging seismic ground motion or fault displacement during the preclosure design lifetime is minimal.

The considerable uncertainties about the behavior of the rock under high thermal loads are driving the design to a robust ground support system to support construction, operations, and performance confirmation activities. This system should allow retrieval using standard emplacement equipment, but performance uncertainties should be resolved as quickly as possible through the drift scale test and monitoring early in the performance confirmation stage.

- There is little likelihood that normal water percolation, a rising water table, perched water, could cause enough water to enter the repository during the preclosure period to impede normal operations or retrieval.
- The repository is being designed to accommodate high radiation and temperatures from the waste packages. No additional features are required to allow retrieval even 50 or more years after emplacement starts, when the temperature in the drifts will be near its peak and radiation levels will still require shielding.

**The Retrieval Period.** The retrieval period extends from the time the order to retrieve is given to the time all waste to be retrieved is on the surface. Retrieval planning at the beginning of the period will take an estimated 10 years. The time required for actual retrieval depends on the number of waste packages to be retrieved and whether the conditions of retrieval are normal or abnormal. Under normal conditions, the expected retrieval rate is 1,000 packages per year, requiring about 10 years to retrieve the entire waste package inventory. The entire waste inventory could be retrieved in about 5 years. Abnormal conditions would slow the retrieval rate. However, retrieving the waste packages at about two per day results in meeting the retrieval time.

Assuming an expected planning period of 10 years, the elapsed time from the order to accomplish full retrieval until the last package is on the surface would be 34 years, conforming to 10 CFR Part 60 guidance. The time to retrieve the entire inventory if the drifts have been backfilled has not been calculated. This retrieval schedule would most likely go well beyond both the 24 years cited for abnormal retrieval and the time described in 10 CFR Part 60 guidance as "...about the same time as that devoted to construction of the geologic repository operations area and the emplacement of wastes," currently estimated at 34 years.

**Equipment Development and Prototype Testing.** The operational equipment (handling equipment, locomotives, transporter and gantry) being designed to handle the large unshielded waste packages currently contemplated should work well for both normal emplacement and retrieval operations. However, to allow waste package movement for operational purposes under abnormal conditions (such as rock fall or failed power or rail systems), some special equipment will be required. Proof-of-principle and prototype testing of any specialized equipment designed to handle waste packages in abnormal conditions or to recover them from an accident should be performed before the license to receive and possess waste and the start of waste emplacement. The need and extent of these tests to support planned operations will be determined by a test and evaluation analysis. Proof-of-principle testing will only be required if no supplier performance data exist for the expected conditions. Since this equipment will also serve for retrieval under abnormal conditions, the retrievability requirements do not impose additional needs for equipment development and testing beyond those required for preclosure operations.

**Compliance and Licensing Needs.** To determine the information on retrieval needed for developing the *Licensing Application (LA)*, the Draft Regulatory Guide 3003 on the format and content for the license application was examined and a list of 21 questions developed that this study should attempt to address. Table 8-2 indicates the sections of this report that either answer these questions or suggest how the information required to answer them can be developed.

## **RECOMMENDED RETRIEVAL STRATEGY**

The recommended strategy incorporates most of the features of the earlier strategy from the *Site Characterization Plan*. However, the proposed strategy recognizes that under the current design concept the requirements for "proof of principle" and prototype tests conducted to show that retrieval will be possible will be met by tests. These tests are required to assure that, during the operational period, waste packages can be reached and moved under both normal and abnormal conditions. The strategy includes steps to assure that land for storage and transportation rights of way that could be needed for retrieval will be available until repository closure. The strategy also makes clear that detailed design and construction requirements for retrieval should be deferred until the time of retrieval so they can be based on the actual conditions that will be encountered.

The key elements of the recommended strategy, which are described in detail in Section 8, are:

- *Maximize use of equipment, facilities, and procedures designed for repository operation.*

Tie retrieval as closely as possible to the emplacement method, using the same systems and equipment and following the same steps in reverse order, to avoid the need for development and testing of specialized equipment required only for retrieval. To the maximum extent possible, use the existing repository surface and subsurface facilities for retrieval. At the end of repository loading, decontaminate and mothball the waste handling building for possible reuse during retrieval. To adapt to actual retrieval conditions most effectively, defer design and construction of any additional facilities required for retrieval operations, such as additional shafts, until the time of retrieval.

- *Add flexibility for easy retrieval*

Provide access for retrieval into each emplacement drift from the east and west main drifts. Design the waste package so that remotely-operated specialized equipment can be used to retrieve the package from either end under abnormal conditions such as rockfall.

- *Preserve the option of continued use of the repository*

Design the repository to allow concurrent emplacement and retrieval of waste packages. Develop approaches for partial retrieval, such as all the packages in a particular area, or only certain types of packages. Ensure that, for partial retrieval in which continued use of the repository is contemplated, the design, methods and the equipment used do not adversely affect waste isolation.

- *Make initial provisions for storage and transportation of retrieved waste.*

Size and locate on a plot plan, before the license application, a site for a temporary surface storage facility that has the flexibility to store the entire planned waste inventory of the repository. Further evaluate the site for storage suitability before the license to receive and possess waste and reserve the site and any needed transportation rights-of-way until repository closure, but defer the design and construction of the facility until the time of retrieval.

- Each emplacement drift shall require retrieval capabilities from the East Main and the West Main for maximum flexibility.
- For partial retrieval, the design, methods used for retrieval, and the equipment shall not negatively affect isolation.
- If additional facilities are required to support retrieval operations, such as additional shafts, or additional support equipment, the design and construction will be accomplished at the time of retrieval to better assess actual retrieval conditions.
- The waste package design will provide a means to allow remotely-operated, specialized equipment to retrieve a waste package under abnormal conditions such as a rockfall.
- The need for proof-of-principle testing for systems and components required to function in a hostile environment will not be required, if supplier performance data exists for the conditions expected to encounter.
- There is no basis for specifying the location of waste packages in the emplacement drifts to make retrieval easier.
- If a branch rail line is built from a mainline railroad to Yucca Mountain, the land withdrawal or right-of-way obtained shall extend until permanent closure of the repository.

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